Forest Landowner Management Decisions & Connections with the Resilience of Lake Champlain to Extreme Events

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Introduction

This project is a small part of a much larger collaboration evaluating the effects of land use decisions on Lake Champlain in a changing climate as part of Vermont EPSCoR's Basin Resilience to Extreme Events (BREE) program. We have been working directly with Dr. Elizabeth Doran, a postdoctoral fellow at the University of Vermont who is developing a model of nutrient flows into Lake Champlain with funding from EPSCoR. The agent-based model developed as part of the BREE program seeks to improve our understanding of the role of individual land management decisions on the resiliency of Lake Champlain to algal blooms, particularly in a changing climate that will feature a higher frequency of extreme storm events. Our contribution to this project involved collecting data with a narrow focus on the management practices of forest landowners in Addison County, VT, and an investigation of the ways their management decisions are impacted by their concern about climate change and water quality.

Climate change is a fundamentally global problem, and its effects will vary greatly by region (Karl and Trenberth, 2003). Some of these changes have already been measured in the Champlain Valley, and are expected to continue in the coming decades. By mid-century, these changes are projected to include a 3.1ºC increase in mean temperature, a 7.1% increase in annual precipitation, a 29% decrease in annual days below freezing, and a 310% increase in annual days above 32.2ºC. Additionally, extreme weather events (in this case, precipitation events in the highest 1% of intensity) are anticipated to increase in frequency by 11.9% in this time frame in the Champlain Valley (Guilbert et al., 2014). Dr. Doran's goal is to use these climatic projections to assess how climate change will affect the likelihood of algal blooms in Lake Champlain, which depends on both the temperature of the lake and nutrient flows within the entire Champlain watershed.

Understanding how nutrients flow into Lake Champlain requires an understanding of both the land and its owners. While many laypeople may be familiar with the impact of agricultural (Sims et al., 1998) and urban (Schueler and Simpson, 2001) lands on nutrient loading, it is important to note that forested land also contributes to phosphorus loading in lake systems, and the Champlain Basin is a prime example. About two thirds of the land in the Lake Champlain Basin is forested, and some estimates attribute up to 21% of the phosphorus entering the lake to these lands. Though natural erosion of soil contributes to this phosphorus loading, road construction and timber harvesting accelerate this process by compacting soil and reducing

the ability of forested land to retain and slow down water during precipitation events (LCBP, 2015). In Vermont, 62% of forested lands are privately owned by families and individuals, which makes their collective management decisions cover more than three times the area of both private commercial forestry and state-managed forest lands (Vermont Department of Forests, Parks and Recreation, 2015).

Given the large area covered by forested lands in the LCB, understanding the management decisions that owners of forested land are making now and how those decisions may change in the future is important to the model Dr. Doran is developing. Building off previous work conducted by Dr. Doran and Mikayla Haefele ‘20 in Chittenden County, we spent the fall 2019 semester interviewing private family forest landowners in Addison County (and one landowner in Huntington). We asked about their land, their plans for the future, and their thoughts on climate change and water quality. Data from these interviews will contribute to both Dr. Doran’s nutrient flow model and an online resource we have developed with information for the public to learn about the management practices currently taking place, their impacts on Lake Champlain, and goals for the future.

We hoped to interview landowners with differing property sizes, management goals, and engagement with land use programs like conservation easements and Vermont’s Use Value Appraisal program, also known as Current Use. The Current Use program is part of legislation passed in Vermont in the 1970s which allows landowners who own 25 acres or more of land to establish a forest management plan and agree to leave the land undeveloped in return for reductions in property taxes (State of Vermont, 2019). We hoped to speak both with people enrolled in Current Use and with those not in the program to see if opinions and approaches to forest land management differed based on engagement with land management programs.

Methods:

We reached out to potential forest landowners in several ways. David Brynn of Vermont Family Forests (VFF), an organization dedicated to the conservation of forest and water quality in Vermont through consulting, research, and community engagement, graciously provided us with a list of contacts who are part of his organization. We sent emails to each of these landowners and conducted interviews with 12 of them. All were enrolled in the Use Value Appraisal program and had existing forest management plans. In an effort to reach landowners not enrolled in Current Use, we also posted information about our project on Front Porch Forum (FPF), a popular Vermont community forum. We interviewed 2 people after connecting on FPF, neither of whom had enrolled their land in Current Use. Of the 14 landowners interviewed, 13 owned land in Addison County and one owned land in the adjacent town of Huntington in Chittenden County. For the sake of simplicity, we will refer to these landowners simply as Addison County landowners.

Interviews were conducted both in person and through phone calls, and followed a semi-structured format previously developed by Doran and Haefele in Chittenden County (see Appendix 1). Many of the questions asked were derived from questions in version 6 of the Vermont National Woodland Owner Survey (USDA Forest Service, 2017). All interviews were conducted following IRB guidelines by researchers who had completed appropriate human ethics trainings, and all interviewees gave written consent for the use of their conversations in our research.

We took care when conducting interviews not to influence the responses of our participants via leading questions or poor question order. For example, given our interest in participants' concerns about climate change and water quality, we asked questions about forest management plans and logging frequency before discussing climate and hydrology. Out of the 14 interviews, 12 participants were recorded using personal recording devices (often cell phones or computers) and transcribed using Otter.ai software. During the other two interviews, we took notes and recorded our findings in our final cumulative database on our Google Drive.

Data analysis

We transcribed our interviews using the Otter.ai software platform, Version 2.2.14 (AISense, Inc). Since Otter.ai does not transcribe with 100% accuracy, we reviewed and edited

the transcripts to correct any inaccuracies. We then analyzed the content of the transcripts using R Studio, Version 1.2.1335 (RStudio Team, 2015). The first analysis we did in Google Sheets involved analyzing and visualizing private landowner's top 3–5 land management priorities. In this type of analysis, we grouped people's responses into categories and graphed the number of interviewees who listed each category as a priority in the interview. For example, "habitat rehabilitation" and "wildlife protection" would both go under the "wildlife habitat" category since both priorities are centered around wildlife wellness.

Since our interviews were semi-structured and mostly conducted as conversations, this type of analysis was not applicable to most questions. Another method we used for data analysis involved using Google Sheets to "code" the data based on affirmative or negative responses. For example, if a landowner is concerned about climate change, then that individual was assigned a "1" value. If the landowner was not concerned about climate change, then the individual was assigned a "0" value. We then graphed these data to visualize our findings. We applied this method to all the data we deemed fit for this type of analysis (Appendix 2). This data analysis helped us identify patterns in our data and allowed us to explore further questions based on our preliminary findings.

To further our exploration of the data, we analyzed our interviews in the open source software R Studio. Initially, we believed a sentiment analysis might reveal the overall "tone" of the interview or specific response. A sentiment analysis is the process of identifying and categorizing words using computational methods in order to gain an overall tone of the text, usually either positive, negative, or neutral. The "afinn" package we used in our sentiment analysis assigns a value to each word based off the "positivity" or "negativity" of the word. For example, the word "thrilled" might be assigned a 3, whereas the word "disappointed" would be assigned a -2. We then sum the total sentiments for each transcript to gauge an overall tone of the response or interview. Other sentiment packages will export a list of emotions associated with each word in the interview. For example, "abandonment" might involve "sadness" or "anger." We choose the "afinn" package to run our sentiment analysis because we wanted a numeric value so we could compare values across interviews.

We performed a sentiment analysis on the responses to the questions "Are you concerned about climate change?" and "Are you concerned about water quality?" After our analysis, we found that the sentiment value did not reveal any trends in the data. We hypothesize that this is

because people addressed such a wide variety of topics when asked about climate change and water quality. For example, some people responded by voicing their concern and then praising our senior seminar work, which would result in a misleading positive sentiment.

After finding no decisive results from the sentiment analysis, we decided that a word count might be a better tool to analyze our data. This type of analysis involves counting the number of times interviewees use certain words in response to selected questions. We used R Studio to find the most commonly used words in an interview response to our questions about concern for climate change, extreme weather events, and water quality. To see our code for this analysis, please refer to Appendix 3. Not all interviewees answered these questions directly, so we filtered interviewee responses for each question individually.

Results

After introducing ourselves and the study, we asked the interviewees their age. Figure 1 below is a histogram showing the age distribution of interviewee age. As is apparent in the graph, most interviewees are 60-75 years old:

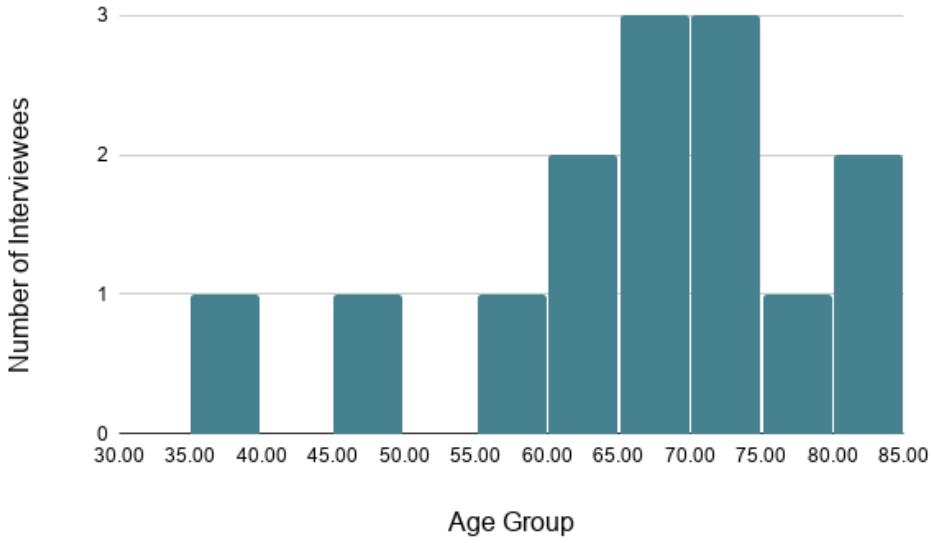

Figure 1. Age distribution of private forest landowners (n=14) interviewed in the study.

As discussed in the data analysis section above, we used Google Sheets to analyze and graph interviewee responses. Figure 2 below is the graph of the reported priorities when we asked interviewees to list their top 3-5 priorities:

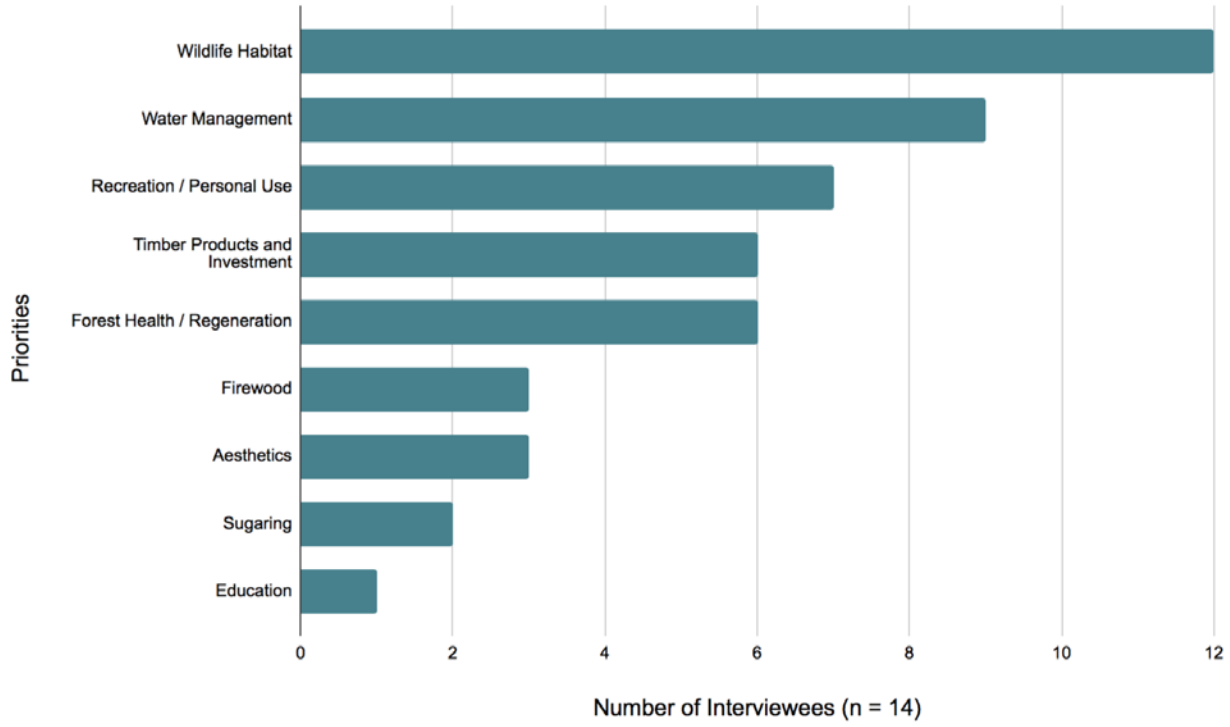

Figure 2. Bar chart showing the main priorities of 14 forest landowners interviewed, when asked for 3-5 priorities with regard to their forested land.

When we "coded" the data by affirmative or negative responses, we found the most interesting responses when we asked landowners the following four questions: 1) Are you concerned about climate change? 2) Are you concerned about water quality? 3) Have you experienced extreme weather events? 4) If yes, has it changed the way you manage your forest land? We highlight our key findings in Figure 3 below.

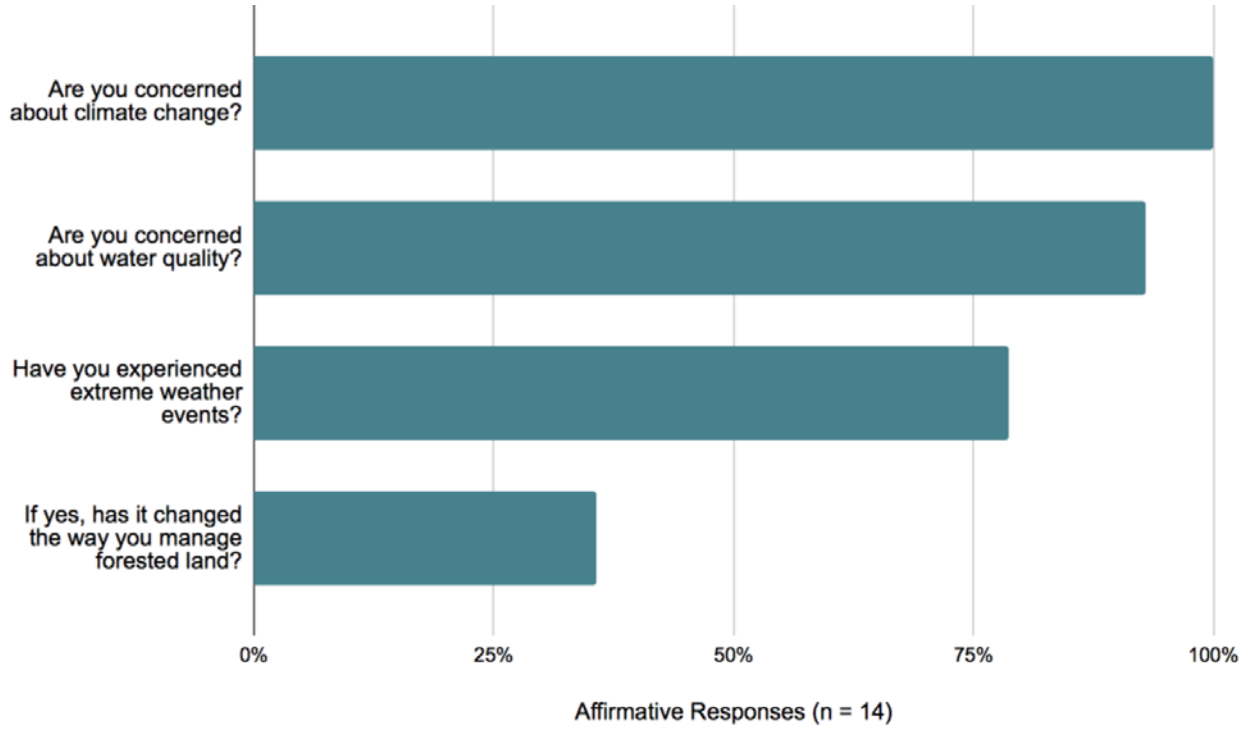

Figure 3. Trends of answers to significant questions in our semi-structured interviews depicting private landowner engagement with forest land management in relation to the larger climate question.

As discussed above, we used R Studio to execute a word count on interviewee responses. Since we often discussed extreme events and potential changes to management in the same question, we grouped and analyzed the responses according to the following questions: 1) Are you concerned about climate change?; 2) Have you experienced extreme weather events, and has it changed the way you manage your forested land?; and 3) Are you concerned about water quality? Our results are presented in Table 1 below.

Table 1: Word count results for climate-related questions, listed in order of frequency mentioned. Words in bold were common words found in multiple questions. The words *yeah*, *lot*, and *gonna* were removed because they more closely represent stop words than content words. Words with varying tenses or plurality were grouped together.

Question 1: Are you concerned about climate change? (n = 10)	Question 2: Have extreme weather events changed the way you manage your land? (n = 11)	Question 3: Are you concerned about water quality? (n = 12)
people	road(s)	**water**
change	water	quality
climate	**land**	beavers
issue	**trees**	**concerned**
concerned	**concerned**	erosion
inches	woods	**forest**
real	time	**lake**
trees	event(s)	**land**
world	harvest	**lawn**
worry	**pretty**	**Champlain**
age	access	close
Bangladesh	growing	**creek**
country	**lake**	**feel**
cut	**lawn**	keeping
effect	property	Lewis
future	standing	**people**
happen(happening)	**Champlain**	**pretty**
hard	**change(d)**	streams
live(lived)	**creek**	Vermont
natural	**feel**	100
time	**forest**	ago

From this analysis, we understand that people are likely to talk about climate change as a global problem involving multiple generations. When prompted about personal experience and land management, people alter their responses and connect climate change to local topics, such as Lake Champlain and roads.

Discussion

In response to question 1, we notice people tend to use words associated with large scale problems concerning climate change. Words such as “Bangladesh,” “world,” “future,” “country,” and “age” appear in the top 21 most commonly used words. Meanwhile, in question 2, we notice people use words associated with issues closer to home, for example road(s) was mentioned 17 times! Other commonly mentioned words include “Champlain,” “creek,” “property,” and “woods.” We found three overlapping words in response to these two questions - “concerned,” “change,” and “trees.”

From the word count analysis, we understand that when asked generally about climate change, people are likely to link climate change to issues happening at a national or global scale and refer to the future status of our environment. When prompted about personal experience and land management, people shift their responses to local topics, such as Lake Champlain, roads, creeks, and woods.

In response to the question 3, people tended to tie issues of water quality to their personal property or the local region of Vermont. Words such as “land,” “Champlain,” “property,” “streams,” and “Vermont” are the most commonly used words (Table 1). The frequent use of these words shows that landowners generally think about water quality at a local scale. The word “beavers” is the third most commonly used word in response to the question concerning water quality. However, only one interviewee discussed beavers in response to the question about water quality. Therefore, this exposes a potential weakness in using word count as a form of data analysis. If one interviewee mentions a word multiple times in response to a question, the word may become disproportionately significant, even though only one interviewee is responsible. This weakness is further exacerbated since we have a relatively small sample size of 14 interviewees.

During our interview conversations – either over the phone or on walks with private landowners on their forested properties, we noticed that interviewees made connections between

how they manage for water quality on their land and the significance of their actions for the local ecosystem or within their land; yet, we also noticed a disjunction between their goals for managing for water quality on their land and how this connects to large water quality issues in the Lake Champlain Basin. There remained a general sentiment that the management of water quality on their own land was not significant enough to influence water quality in the basin. Mostly, when prompted with questions surrounding water quality, interviewees would provide responses about drinking water and for some, the wells on their land that source their own drinking water.

The ages of the forest landowners that we interviewed ranged from 35 to 83 (Fig. 1). From this pool of people, we have identified a mix of working and retired individuals. There is a mix of those who have inherited their land from previous generations to those who have purchased their land in the past few years. The most common impression seen in interviews in terms of future succession plans is that, generally, forest landowners have not planned for future succession and are keeping the option open for their children to inherit the land if they wish to. Current Use programs in Vermont are renewed every ten years, which would provide a timeline of relative certainty in respect to the management of forested land within the program in Vermont. The lack of plans for the future project the possible instability of land use and management for privately owned forestland in coming years; each landowner who inherits the land may have different priorities and knowledge of the land compared to the prior owner and can be more likely to opt out of or adapt the previous landowner's plans to match their own priorities. Without foreseeable succession plans, the future of land use and land management in the Lake Champlain Basin will be unpredictable; correspondingly, the effects of forest landowner decisions and actions on water quality will also be uncertain.

Through analysis of language used in answers to questions regarding climate change and forest landowner responses to climate events, we have found that more interviewees in Addison County provide affirmative responses about their concern in regards to climate change but do not immediately form a connection between the changing climate and their land management practices (Fig. 3). In Figure 3, we see that of the 14 people we interviewed, 100% of them expressed their concern for climate change. Around 70% of these same people have experienced extreme weather events but less than 50% of our 14 interviewees have changed the way they manage forested land because of their concern or experiences with changing environmental

trends. Alternatively, some of these landowners who already have forest management plans may be proactively managing their forested land to mitigate any negative effects of climate change; they have kept their management practices unchanged because they feel that they have already been following sustainable forest management practices. During the semi-structured interviews, one of the questions pertained to the priorities forest landowners had for their forested land; it was an open-ended question that allowed the private landowners the freedom to speak on any priorities they had. The three main priorities concerned wildlife habitat, water management and recreation or personal use on their land (Fig. 2).

Conclusion

The goal of our project was to explore the ways in which private landowners in Addison County are managing their forested land, and whether or not they connect the influence of their management practices to broader issues, such as nutrient runoff into Lake Champlain or climate change mitigation. Through the responses we received from interviewees, we found that people are concerned about both climate change and water quality. Our results highlighted that the people we interviewed consistently connected climate change to broader global trends such as wildfires in California or deforestation in Brazil. In addition to talking about climate change on a global scale, people also discussed it in political or academic terms. Also, people often referred to livelihood adjustments in order to mitigate their carbon footprint such as electric cars or renewable heating mechanisms.

Overall, we found very few people who connected climate change to their forest land management practices until we directly asked the question: “Have you experienced extreme events, and has it changed the way you manage your land?” In response to this question, most people observed that they have experienced extreme events in the form of rainfall. To cope with these rainfall events, people have channeled their efforts into upholding the integrity of their forest to prevent erosion, runoff, and further damage to their land, dwellings, and roads. In general, most interviewees did not immediately connect climate change to their local region.

For the future of the project, we propose that framing forest land management as not only a personal problem, but a greater community problem could help influence forest landowners to be more proactive in preventing harmful runoff from entering Lake Champlain. The results of the research being conducted by our partner, with more extensive studies throughout Vermont,

has the potential to be represented as an educational tool that might change the understanding of forest landowners in terms of their engagement with their forested land and climate change. An emphasis can be made to make clearer connections between changes in forest land management and their relation to more extreme weather events, which may help the landowners to protect both their private land as well as the Lake Champlain Basin.

Online Materials

In addition to interview data, we collected audio and video recordings during several in-person interviews on the properties our interviewees owned (as well as on public trails in other areas of woods and water in Addison County). We compiled these images into an online platform in combination with our statistical results and narratives from interviewees to create an online resource representing our findings. We were unable to find a streamlined way of incorporating video recordings into the webpage, but we provided individual video clips to our partner Dr. Doran so she has access to them if she or someone on her team wishes to use them. The website can be found at https://spark.adobe.com/page/Z6jbZchwJqMsv/, or by scanning the QR code below with a smartphone camera or other internet-connected scanning device.

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Appendix 1: Interview Template

https://docs.google.com/document/d/1QC5FVvT7Ks8-59X83cIHPWmaWBv6Q8nYBwiTYESgseo/edit

Appendix 2: Coding Interview Questions

List of Questions used to "code" data with a "1" representing "Yes" or a "0" representing "No":

1. Has your property been in your family for more than one generation?
2. Have you thought about or made succession plans for the future ownership?
3. Enrolled in Current Use OR conservation easement?
4. Do you have a forest management plan?
5. Have you harvested timber on your land?
6. Do you use your land for maple sugaring?
7. Are you concerned about climate change?
8. Have you experienced extreme events?
9. If yes, has it changed the way you manage forested land?
10. Are you concerned about water quality?
11. Do you allow public or private access to your private land for recreational purposes?
12. Have difference climatic events changed your maple tapping process/time frame?
13. Do you have a reverse osmosis system?

Appendix 3: R Code

Haedrich, S. (2019, December). Retrieved from https://github.com/sarahhaedrich/sarahhaedrich.github.io/blob/master/ENVS401.R